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10 CFR 50.54(f)

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United States Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Braidwood Station, Units 1 and 2
Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket Nos. STN 50-456 and STN 50-457

Byron Station, Units 1 and 2
Facility Operating License Nos. NPF-37 and NPF-66
NRC Docket Nos. STN 50-454 and STN 50-455

Subject: Supplement to Exelon Response to NRC Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors"

References:
(1) Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," dated September 13, 2004
(2) GSI-191 SE, Revision 0, "Safety Evaluation of NEI Guidance of PWR Sump Performances," dated December 6, 2004
(3) Letter from P. B. Cowan (Exelon Generation Company, LLC and AmerGen Energy Company, LLC) to U. S. Nuclear Regulatory Commission "Exelon/AmerGen Response to NRC Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors" dated September 1, 2005

The U.S. Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2004-02 (Reference 1) on September 13, 2004 to request that addressees perform an evaluation of the Emergency Core Cooling System (ECCS) and Containment Spray (CS) system recirculation functions in light of the information provided in the GL and, if appropriate, take additional actions to ensure system function. Additionally, the GL requested addressees to provide the NRC with a written response in accordance with 10 CFR 50.54(f). The request was based on identified potential susceptibility of the pressurized water reactor (PWR) recirculation sump screens to debris blockage during design basis accidents requiring recirculation operation of ECCS or CS System and on the potential for additional adverse effects due to debris blockage of flowpaths necessary for ECCS and CS System recirculation and containment drainage.

By letter dated September 1, 2005, Exelon Generation Company, LLC (EGC) submitted the second of two responses requested by GL 2004-02. The associated Byron and Braidwood responses to requested information items 2(a) and 2(b) indicated that corrective actions would be implemented to ensure that the ECCS and CS System recirculation functions under debris loading conditions would be in compliance with the applicable regulatory requirements section of the GL when all modifications are completed by December 31, 2007.

EGC's Byron and Braidwood Stations are fully committed to resolving the containment sump issue. Contracts have been awarded for the design, testing, and fabrication of sump strainers. Installation is scheduled for all four of our nuclear units prior to December 31, 2007. In addition, the assessment of downstream effects on components (e.g., pumps, valves), fuel, and reactor internals has been completed. Chemical effects assessments are ongoing for each unit.

The completion of the corrective actions committed to in our September 1, 2005 letter for Byron Unit 2 and Braidwood Unit 1 are on track for December 31, 2007 as required by Generic Letter 2004-02. Byron Unit 1 and Braidwood Unit 2 are also both currently scheduled to have new strainers installed during their respective Fall 2006 refueling outages; however, both are facing challenges to the installation schedule for the downstream effects related modifications. As such, a short extension to the completion schedule for downstream effects related modifications is respectfully requested.

EGC requests that the completion of modifications to mitigate downstream effects for both Byron Unit 1 and Braidwood Unit 2 be extended until the Spring 2008 outages for those units. Note that new ECCS sump strainers will be installed for all Byron and Braidwood Units by December 31, 2007 in accordance with the Generic Letter 2004-02 commitments.

Attachment 1 to this letter provides the bases for our conclusions that it is acceptable to extend the completion of the corrective actions required by Generic Letter 2004-02 for both Byron Unit 1 and Braidwood Unit 2 until the Spring 2008 outages. Additionally, this attachment outlines the mitigating actions that will be taken in the 2006 refueling outages to improve existing margins until the final design can be implemented. It is respectfully requested that the NRC respond to this request by June 15, 2006 to allow proper planning for the Fall outages.

If you have any questions or require additional information, please contact Mr. Doug Walker at (610) 765-5726.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 31st day of May 2006.

Respectfully,

Keith R. Jury

Keith R. Jury
Director – Licensing and Regulatory Affairs

Attachments:
1. Technical Justification to Extend Completion of Downstream Effects Related Modifications
2. List of Additional Commitments
3. Specifications of ECCS / CS System Equipment

Attachment 1

Byron Station, Unit 1
Braidwood Station, Unit 2

Technical Justification to Extend Completion of Downstream Effects Related Modifications

Introduction

By letter dated September 1, 2005, Exelon Generation Company, LLC (EGC) submitted the second of two responses requested by Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors." The associated Byron and Braidwood responses to requested information items 2(a) and 2(b) indicated that corrective actions would be implemented to ensure that the emergency core cooling system (ECCS) and containment spray (CS) system recirculation functions under debris loading conditions would be in compliance with the applicable regulatory requirements section of the Generic Letter when all modifications are completed by December 31, 2007.

EGC's Byron and Braidwood Stations are fully committed to resolving the containment sump issue. Contracts have been awarded for the design, testing, and fabrication of sump strainers. Installation is scheduled for all four of our nuclear units prior to December 31, 2007. In addition, the assessment of downstream effects on components (e.g., pumps, valves), fuel, and reactor internals has been completed. Chemical effects assessments are ongoing for each unit. The following analysis/testing has been (or will be) performed to address the GSI-191 issue and to ensure adequate Net Positive Suction Head (NPSH) for ECCS Pumps:

- NEI 02-01 and Latent Debris Walkdowns performed
- Debris Generation Analysis performed
- Containment Transport Analysis (includes Computational Fluid Dynamics) performed
- Head Loss Analysis performed
- Vendor's Strainer Head Loss Testing performed (w/o chemical effects)
- Bypass testing performed
- Downstream Effects analysis performed (per WCAP 16406-P)
- Chemical Effects Testing (scheduled completion June 2006)
- Supplemental head loss testing (scheduled completion June 2006)

The completion of the corrective actions committed to in our September 1, 2005 letter for Byron Unit 2 and Braidwood Unit 1 are on track for December 31, 2007 as required by Generic Letter (GL) 2004-02. In addition, Byron Unit 1 and Braidwood Unit 2 are also both currently on track to have new strainers installed during their respective Fall 2006 refueling outages; however, both units are facing challenges to the installation schedule for the downstream effects related modifications. As such, a short extension to the completion schedule for downstream effects related modifications is respectfully requested.

EGC requests that the completion of modifications to the ECCS throttle valves and the cyclone separators for the CS System pumps (four total) for both Byron Unit 1 and Braidwood Unit 2 be extended until the Spring 2008 refueling outages at those units. Note that new ECCS sump strainers will be installed for all Braidwood and Byron Units by December 31, 2007 in accordance with the Generic Letter 2004-02 commitments.

Reason for the Request for Extension

Byron and Braidwood have performed analysis of downstream effects in accordance with WCAP 16406-P, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191." The following components were evaluated for wear and plugging:

- Residual Heat Removal (RHR) Pumps and Heat Exchangers
- ECCS Pumps
- CS System Pumps, Spray Eductors and Nozzles
- Flow Orifii (restricting and flow element)
- Throttle Valves
- Instrumentation
- Piston Check Valves
- Relief Valves
- Reactor fuel and vessel internals

The CS System Pump Seal Flushing Line Cyclone Separators and the ECCS throttle valves were identified as being susceptible to debris plugging. Note that only eight of the twelve ECCS throttle valves per Unit have been identified as being susceptible to debris plugging. As noted earlier in this document, Byron Unit 1 and Braidwood Unit 2, which have refueling outages planned for the Fall of 2006, are both facing challenges to the installation schedule for the downstream effects related modifications. Specifically, parts and testing of eight ECCS throttle valves per unit and the two CS System Pump Seal Flushing Line Cyclone Separators per unit, may not be complete in time for the Fall 2006 Refuel Outage.

EGC is evaluating the replacement of the Cyclone Separator with a pressure breakdown device. A preliminary schedule has been developed which includes finalization of the design and procurement and installation of the modification in accordance with the Spring 2008 refueling outage schedule.

In addition, EGC has elected to modify all twelve ECCS throttle valves in order to ensure potential plugging and hydraulic related concerns are mitigated. Modification of the throttle valves includes replacement of trim and some pressure retaining parts on twelve valves/unit and downstream orifii.

The schedule for resolution of modifications (detailed below) to the ECCS throttle valves requires time to fully shop test the new ECCS valve trim and orifii prior to installation. The importance of comprehensively testing the new valve trim is demonstrated through numerous operational experience events involving the degradation of ECCS throttle valves due to cavitation (refer to documents listed in the References Section at the end of this document). In addition, NRC Information Notice IN 97-76, "Degraded Throttle Valves in Emergency Core Cooling System Resulting From Cavitation-Induced Erosion During a Loss-Of-Coolant Accident," was issued to describe potential problems caused by degradation of ECCS throttle valves in the intermediate-head safety injection pump hot-leg and cold-leg flow paths and in the charging pump (high-head safety injection) cold-leg flow paths during certain loss-of-coolant accident (LOCA) scenarios.

Plant-Specific Technical/Experimental Plan

As identified in NRC SECY 06-0078, "Status Of Resolution Of GSI-191, 'Assessment Of [Effect Of] Debris Accumulation On PWR Sump Performance,'" certain criteria must be addressed to support station requests for extension beyond the December 31, 2007 GL commitment date. One of the criterion states:

> "..the licensee has a plant-specific technical/experimental plan with milestones and schedule to address outstanding technical issues with enough margin to account for uncertainties."

The ECCS throttle valves require careful setup and testing prior to installation in the system. The installed valves must be able to pass a particle size (plus margin) that could be passed by the new sump screens (i.e., the screen hole size is being modified from 3/16" to 1/12"). Additionally, the valves must be able to throttle and balance injection flows in service to maintain safety system operability. The clearance associated with the current throttle valve position at Byron Station and Braidwood Station has been found to be susceptible to debris plugging. Several alternatives were evaluated to resolve this issue including:

- Change the orifice size downstream of throttle valves so that valves can be opened farther – this is not desired because analysis predicted cavitation.
- Replace valves with new valves having a larger C_v range – this is not desired because of very long lead times or inability to acquire entire valve.
- Replace installed valve trim and eliminate/modify orifii – this is the desired solution because of a successful preliminary analysis; however, this requires shop testing to demonstrate that the new valves will perform acceptably in the plant.

EGC has evaluated the alternatives to procure and test parts for the planned modifications and the lowest risk option to the ECCS system is estimated to take 38 weeks from May 1, 2006.

		Schedule Date
Procure Parts for testing	14 weeks	8/04/06
Valve Testing	2 weeks	8/18/06
Procure Parts for installation	22 weeks	01/19/07
Total	38 weeks	Mid-January 2007

Full evaluation and shop testing is needed to confirm acceptable valve trim design and impact on ECCS performance. The above schedule allows sufficient time to incorporate any lessons learned from the shop testing into the final design of the trim parts and thus represents the lowest risk for an adverse impact on the ECCS design. This schedule does not support the Fall 2006 refueling outages scheduled for Byron Station Unit 1 and Braidwood Station Unit 2; however, there is ample time to support installation in the Spring 2008 refueling outages for these units. The extension requested would support the parts procurement and testing prior to installation with sufficient margin to account for uncertainties.

EGC is evaluating the replacement of the cyclone separator with a pressure breakdown device. Upon finalization of the design for the cyclone separator, parts will be procured and installation will be planned in support of the established Byron Unit 1 and Braidwood Unit 2 pre-outage milestones for the 2008 Spring refueling outage.

Mitigative Measures

Byron and Braidwood are continuing their efforts to complete the corrective actions committed to in the September 1, 2005 GL 2004-02 response. Byron and Braidwood are currently on schedule to install new sump screens for all Units by December 31, 2007. The schedule is as follows:

Byron Unit 1 (Fall 2006)
Braidwood Unit 2 (Fall 2006)
Byron Unit 2 (Spring 2007)
Braidwood Unit 1 (Fall 2007)

As previously stated, NRC SECY 06-0078 provides "Criteria for Evaluating Delay of Hardware Changes" which must be addressed to support a request for extension. The second criterion states:

> *"..the licensee identifies mitigative measures to be put in place prior to December 31, 2007, and adequately describes how these mitigative measures will minimize the risk of degraded ECCS and CSS functions during the extension period."*

In support of this extension, EGC notes that the following favorable conditions exist at Byron Station and Braidwood Station:

- Bulletin 2003-01 procedural guidance regarding foreign material exclusion (FME) controls and, improvements to loose debris surveillances;
- Bulletin 2003-01 training and procedural guidance to expedite plant cooldown in response to a small break LOCA:
- Byron and Braidwood do not utilize calcium silicate insulation or tri-sodium phosphate as a buffer;
- Braidwood Unit 2 piping and equipment insulation inside containment is virtually all Reflective Metal Insulation (RMI) type insulation
- Application of the leak-before-break analysis principle has been approved by the NRC Staff for Byron Station and Braidwood Station in relation to breaks in the reactor coolant loop primary piping, accumulator line piping, and reactor coolant loop bypass piping.
- The NPSH analysis for the CS System pumps and the RHR pumps do not credit containment overpressure.
- An enhanced containment cleanliness program with specific loose debris attention has been incorporated as part of the Bulletin 2003-01 response.

In addition to the existing favorable conditions, Byron Unit 1 and Braidwood Unit 2 plan for additional mitigative measures to be taken during the Fall 2006 refueling outage, including:

- Installation of new replacement sump strainers in each sump (two sumps per unit). The new sump screens are relatively large, approximately 3000 sq. ft./sump, when compared to the current sump screen area of approximately 150 - 250 sq. ft. (the screen area varies as water level changes).
- New screen mesh size will be smaller than current (1/12" versus 3/16" currently).
- Install trash racks upstream of new sump screens for large debris interception.
- Byron Station Unit 1 will remove fiberglass insulation on mid-section of steam generators and connecting piping within the Zone of Influence (ZOI), replace with Reflective Metal Insulation (RMI) (i.e., alleviates fiber debris load at sump screen).
- The size of the replacement strainers is based on conservative debris quantities. For example, the quantity of qualified coating debris is based on the 10 Diameter ZOI while preliminary industry test data indicates that the ZOI could be substantially reduced.

Risk Impact Evaluation

ECCS post-LOCA Line-up description

In response to a LOCA, the RHR, centrifugal charging (CV), and safety injection (SI) pumps automatically start upon receipt of a safety injection signal. These pumps inject to the reactor coolant system (RCS) cold legs, taking suction from the refueling water storage tank (RWST). This system line-up is referred to as ECCS Injection phase. The Containment Spray (CS) pumps start automatically when the containment pressure reaches the setpoint for CS actuation; the CS pumps also take suction from the RWST. The switchover to the ECCS recirculation sumps as suction source to the RHR pumps is initiated when the RWST water level decreases to approximately 47%.

After the ECCS recirculation line-up is established, the RHR pumps combine to inject to the RCS cold legs and to supply water to the suction of the CV and SI pumps. The CV and SI pumps continue to inject to the RCS cold legs. This line-up is referred to as ECCS cold leg recirculation. At six hours into the event, the ECCS line-up is modified for hot leg recirculation. The RHR pumps supply the suction to the CV and SI pumps and inject to the RCS hot legs. The SI pumps also inject to the RCS hot legs while the CV pumps continue to inject to the RCS cold legs.

The CS pumps continue to take suction from the RWST until the suction source is manually switched over to the ECCS recirculation sumps when the RWST water level decreases to approximately 12%.

Throttle valves are located on the discharge line from the SI pumps to the RCS cold legs, the discharge line from the SI pumps to the RCS hot legs, and the discharge line from the CV pumps to the RCS cold legs. For post-LOCA operation, throttle valves are not used on the discharge lines from the RHR pumps to the RCS cold legs and hot legs.

ECCS Throttle Valve Risk Implications

The additional four months of operation (based on the current EGC outage schedule) with the existing ECCS throttle valves in place represents a very small increase in incremental risk. All of the sump strainer replacement modifications will be completed and the fibrous insulation in the ZOI removed prior to December 31, 2007. Therefore, the ECCS and CS System recirculation capability will be enhanced. The new sump strainers will have a smaller mesh size (1/12" versus 3/16" currently). The risk associated with delaying the throttle valve modifications is due to the potential for debris to be transported into the CV and SI systems during the recirculation mode of ECCS operation.

It is not possible to quantify the likelihood of the debris (i.e., downstream debris will likely consist of coatings particles and latent debris) being transported to and significantly plugging the throttle valves; however, a number of factors make the likelihood of such conditions very low.

- The LOCA most likely to transport the debris to the ECCS sumps are (a) large LOCAs due to the large ZOI they present, and (b) LOCAs in which the CS System is actuated and provides an additional generation and transport mechanism. The only LOCAs requiring CV and SI to operate and provide core cooling while in recirculation from the ECCS sump are LOCAs from smaller break sizes. These LOCAs deplete the inventory in the (RWST) and do not cause depressurization of the RCS to pressures below the shutoff head of RHR pumps (i.e., the low head ECCS pumps).
- Based on plant-specific, thermal hydraulic analyses using the Modular Accident Analysis Program (MAAP), LOCAs due to breaks larger than 3" in diameter will result in the depressurization of the RCS and injection from the RHR pumps during the ECCS injection phase. Thus, those LOCAs can be ruled out as sources of risk due to throttle valve plugging because the CV and SI pumps are not required. In these cases, the RHR system will be capable of providing adequate core cooling; therefore, even if the ECCS throttle valves plug, core damage will be prevented.
- The debris that presents the potential plugging concern is distributed throughout the containment. LOCAs that are 3" or smaller in size would be extremely unlikely to dislodge and transport sufficient debris to the ECCS system. This is due to the limited ZOI for the smaller LOCAs and relatively low transport velocities to the ECCS sump for these scenarios.
- LOCAs that are 3" or smaller in size, will not likely pressurize containment sufficiently to actuate the CS System, unless all four Reactor Containment Fan Coolers (RCFCs) fail. Thus, for these smaller break LOCAs, the only transport mechanisms to the ECCS sump are due to the relative low ECCS flow from the CV and SI pumps in recirculation mode.
- Furthermore, in the event of a LOCA, Emergency Operating Procedures direct the plant operators to maximize the cooldown and depressurization rate of the RCS in order to establish the shutdown cooling mode of RHR, thus reducing the likelihood of high head ECCS recirculation. For LOCAs that are 3" or smaller, there is increased probability that operators will successfully cooldown and depressurize the RCS prior to the need for high head ECCS recirculation.

- In order to judge the potential risk implications of a limited plugging level, thermal hydraulic sensitivity studies were performed on the relative flow allowed through the throttle valves for the most limiting 3" LOCA scenario. The results of this sensitivity study showed that even if the operators had failed to cooldown and depressurize the RCS and all the throttle valves were assumed to be sufficiently plugged to reduce the cold leg injection flow from one CV or SI pump by 50%, adequate core cooling would be provided in the ECCS recirculation mode.

EGC has concluded that only a narrow set of circumstances have the potential to increase the risk of core damage during the relative short exposure time of approximately four months and this represents a very small incremental risk increase.

Containment Spray Risk Implications

The risk implications of the CS cyclone separator are distinct from the ECCS throttle valves. The design function of the CS System is to remove iodine from the containment atmosphere in order to reduce the release of fission product radioactivity to the environment and to reduce containment pressure. The CS System performs these functions following larger LOCAs since the system actuates upon containment pressure reaching 20 psig. In addition, for severe accidents, containment spray can have a benefit in reducing the source term associated with a release.

Byron and Braidwood have large, dry containments and, therefore, containment heat removal is not required to prevent large early releases. The CS System is not credited in the PRA because it provides no heat removal from containment during recirculation and is therefore not important for preventing core damage or large early release. Consequently, plugging of the cyclone separators would not impact core damage frequency (CDF) or large early release frequency (LERF). While containment spray is potentially important for delaying and/or reducing the severity of late releases, this impact is expected to be very small due to the short timeframe involved and the low likelihood of a core damage event requiring containment spray for this purpose.

Summary

EGC's request for extension to the completion schedule for downstream effects related modifications is needed to support identified procurement and testing of ECCS throttle valve parts, and finalize modifications to alleviate cyclone separator plugging of the CS System Pumps. Per the criteria listed in SECY 06-0078, EGC has established a plant-specific technical/experimental plan with milestones and schedules to address outstanding technical issues with enough margin to account for uncertainties. Additionally, EGC has identified mitigative measures to be put in place prior to December 31, 2007, and adequately described how these mitigative measures will minimize the risk of degraded ECCS and CS System functions during the extension period.

References - Pertinent Operating Experience (referenced by INPO Event Number):

1. 315-990327-1 Potential Safety Injection Throttle Valve Cavitation
2. 999-971030-1 NRC Information Notice IN 97-76, "Degraded Throttle Valves in Emergency Core Cooling system Resulting From Cavitation-Induced Erosion During a Loss-Of-Coolant Accident"
3. 445-971002-1 Minimum Gap For Cold Leg Injection Throttle Valves Not In Accordance With Design Basis
4. 275-970918-1 Potential Post-LOCA Pump Runout Due To Throttle/Balancing Valve Degradation
5. 275-951101-1 Potential Clogging of ECCS Throttle Valves
6. 456-950828-1 Inadequate Surveillance Procedure Could Have Led to ECCS Inoperability Due to Personnel Error and Management Deficiency
7. 275-940624-1 Insufficient Component Cooling Water Flow To Charging Pump Oil Coolers
8. 390-931222-1 Inappropriate Selection Of Valve For Use As A Throttle Valve In The Safety Injection System.
9. 390-930914-1 Inappropriate Selection Of Throttle Valves For Safety Injection System
10. 339-920413-1 Cold Leg Safety Injection Branch Line Flow Below Technical Specification Requirements Due To Throttle Valve Position.
11. 272-761211-2 Safety Injection Throttle Valve Inoperability
12. 423-960830-1 Deficiency In Setting Of Emergency Core Cooling System Throttle Valve Positions
13. 327-950302-1 Potential Post Large Break LOCA ECCS Pump Runout Damage Due To Throttle/Balance Valve Erosion
14. 295-940219-1 Cold Leg Safety Injection Flow Rate Low Due To Mispositioned Throttle Valves

Attachment 2

Byron Station, Unit 1
Braidwood Station, Unit 2

List of Additional Commitments

Attachment 2
Byron Station, Unit 1
Braidwood Station, Unit 2
List of Additional Commitments

The following table identifies commitments made in this document by Exelon. Any other actions discussed in the submittal represent intended or planned actions. They are described to the NRC for the NRC's information and are not regulatory commitments.

COMMITMENT	COMMITTED DATE OR "OUTAGE"	COMMITMENT TYPE	
		ONE-TIME ACTION (Yes/No)	PROGRAMMATIC (Yes/No)
Byron Station, Unit 1 will complete GL 2004-02 downstream effects related modifications to the ECCS throttle valves and the CS System cyclone separators prior to the completion of the Spring 2008 refueling outage	Spring 2008 refueling outage	Yes	No
Braidwood Station, Unit 2 will complete GL 2004-02 downstream effects related modifications to the ECCS throttle valves and the CS System cyclone separators prior to the completion of the Spring 2008 refueling outage	Spring 2008 refueling outage	Yes	No

Attachment 3

Byron Station, Unit 1
Braidwood Station, Unit 2

Specifications of ECCS / CS System Equipment

Attachment 3
Byron Station, Unit 1
Braidwood Station, Unit 2
Specifications of ECCS / CS System Equipment

Residual Heat Removal (RHR) Pumps

Ingersol-Rand	Model 8x20 WDF
Shut Off Head (SOH)	465 ft.
Run-out Flow	5000 gpm
Impeller Material	ASTM A351-GRCA6NM (BHN 248-302)
Casing Ring Material	K-Monel
Stuffing Box Bushing	K-Monel
Shaft Sleeve	ASTM 216 TP 410
Seal	#5 Carbon
Seal Ring	Tungsten Carbide
Casing Ring Clearance	0.023 inch
Stuffing Box Bushing Clearance	0.025 inch

Safety Injection (SI) Pumps

Pacific Pumps	Model 3"-JHF – 10 Stage
SOH	3600 ft.
Run-out Flow	675 gpm
Stages	10
Impeller Material	A296 CA 40
Bushing / Wearing Ring Material	A276 Type 440A
Pressure Reducing Sleeve	A276 Type 420
Pressure Reducing Bushing	A276 Type 440A
Seal – Primary Ring	Carbon
Seal – Mating Ring	Tungsten Carbide
Wearing Ring Clearance	0.010 inch
Pressure Reducing Bushing (Balancing Drum) Clearance	0.010 inch

Centrifugal Charging (CV) Pumps

Pacific Pumps	Model 2.5" RLIJ – 11 Stage
SOH	6100 ft.
Run-out Flow	550 gpm
Stages	11
Impeller Material	A296 CA 40
Bushing / Wearing Ring Material	A276 Type 440A
Pressure Reducing Sleeve	A276 Type 420
Pressure Reducing Bushing	A276 Type 440A
Seal – Primary Ring	Carbon
Seal – Mating Ring	Tungsten Carbide
Wearing Ring Clearance	0.010 inch
Pressure Reducing Bushing (Balancing Drum) Clearance	0.010 inch

Containment Spray (CS) Pumps

Ingersol-Rand	Model 8x23 WDF
SOH	595 ft.
Impeller Material	ASTM A487-CA6NM (BHN 248-302)
Casing Ring Material	Monel K-500 (BHN 265)
Stuffing Box Bushing	AISI 410 Cond. H (BHN 352-415)
Shaft Sleeve	AISI 410 Cond H (BHN 262-302)
Seal Insert	#5 Carbon
Seal Ring	Tungsten Carbide
Casing Ring Clearance	0.023 inch
Stuffing Box Bushing Clearance	0.025 inch

SI Manual Throttle Valves (Installed Equipment)

Valve ID #	1/2SI8810A-D
Manufacturer	Copes Vulcan
Valve Size and Type	1-1/2", Class 1513 Manual Throttle valve ASME Code Class 1, reduced port globe.
Body	ASME SA-182 GR. F-316
Bonnet	ASME SA-182 GR. F-316
Plug	ASTM A-276, type 420
Cage	ASTM A-276, type 420
Stem	ASTM A-276, type 316

Valve ID #	1/2SI8816A-D
Manufacturer	Copes Vulcan
Valve Size and Type	2", Class 1500 Manual Throttle valve ASME Code Class 2, reduced port globe.
Body	ASME SA-182 GR. F-316
Bonnet	ASME SA-182 GR. F-316
Plug	ASTM A-276, type 420
Cage	ASTM A-276, type 420
Stem	ASTM A-276, type 316

Valve ID #	1/2SI8822A-D
Manufacturer	Copes Vulcan
Valve Size and Type	2", Class 1500 Manual Throttle valve ASME Code Class 2, reduced port globe.
Body	ASME SA-182 GR. F-316
Bonnet	ASME SA-182 GR. F-316
Plug	ASTM A-276, type 420
Cage	ASTM A-276, type 420
Stem	ASTM A-276, type 316

SI Manual Throttle Valves (GSI-191 Modification material – Trim kits)

Valve ID #	1/2SI8810A-D
Manufacturer	Copes Vulcan
Configuration	Multi-stage HUSH trim.
Plug	ASTM A-276, type 420
Cage	ASTM A-276, type 420
Stem	ASTM A-276, type 316

Valve ID #	1/2SI8816A-D
Manufacturer	Copes Vulcan
Configuration	Multi-stage HUSH trim.
Bonnet	ASME SA-182 GR. F-316
Plug	ASTM A-276, type 420
Cage	ASTM A-276, type 420
Stem	ASTM A-276, type 316

Valve ID #	1/2SI8822A-D
Manufacturer	Copes Vulcan
Configuration	Multi-stage HUSH trim.
Plug	ASTM A-276, type 420
Cage	ASTM A-276, type 420
Stem	ASTM A-276, type 316

Hush Trim: The solution being designed for each valve is a Copes Vulcan multi-staged cage trim. This trim provides a series of hollow cylinders (cages) with drilled holes, each cage slightly offset from the next. As the valve opens and the plug rises, this design incrementally exposes the holes in the cage to flow. All exposed holes are larger than the minimum size required to pass the largest postulated particle size. This design spreads the pressure drop across the multiple stages and minimizes the likelihood of cavitation.